

PATENT SPECIFICATION (11)

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(54) IMPROVEMENTS IN OR RELATING TO ELECTRONIC FLASH DEVICES WITH LIGHT-OUTPUT CONTROL

(71) We, BRAUN AKTIENGESellschaft, a German Body Corporate, of 22 Rüsselsheimer Strasse, 6 Frankfurt-am-Main, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to electronic flash devices with automatic light-output control. Such flash devices may comprise a flash tube which can be ignited by a trigger contact, a capacitor to supply said flash tube, and a control circuit, containing a photosensitive component, for an electronic switch arranged in series with the flash tube.

In such electronic flash units the ignition of the flash tube is normally effected, on closure of the trigger contact, by the discharge of an ignition capacitor across an ignition transformer. Simultaneously with the ignition of the tube, the electronic switch is placed in its conductive condition and the ignition circuit thus closed. Part of the light reflected from the illuminated object is then picked up by the photosensitive component which, through an associated part of the control circuit, produces an integrated voltage which in turn brings about operation of the electronic switch to interrupt the ignition circuit.

In order to place the electronic switch in its conductive condition, in known circuit arrangements a voltage-divider is provided in the primary circuit of the ignition transformer, across which voltage-divider the control voltage for the electronic switch is picked off.

It has been found that when triggering takes place, and due to the closing of the oscillatory circuit formed by the ignition capacitor and the primary winding of the ignition transformer, a damped oscillation can develop the negative half-wave of which returns the electronic switch to its conductive state. The flash tube then exhibits an after-flash effect.

The electronic switch may take the form of a thyristor but it is desirable for economic and other reasons to make use of thyristors of readily available types in which the discharge can be initiated but not stopped by a control voltage.

Because, however, due to the relatively small current through the voltage divider, there is only a relatively low control voltage available, a relatively long time is required before the thyristor becomes fully conductive so that in consequence of the initially high forward resistance, if undesirable heating is to be avoided a thyristor with a very high dissipation rating is necessitated.

It is a disadvantage, too, that following an ignition discharge and on recharging, the control signal continues to be applied to the gate of the thyristor until the ignition capacitor has fully charged up again. This means that particularly at close range, because of the long recharging pulse, difficulties arise in the context of the switching off of the thyristor, that is to say, the return of the unit to the readiness condition is a relatively long process.

Because the operating period of known flash units of the kind referred to is short, there is moreover a requirement that such units should be provided with some indication that they are ready for operation, in order to avoid incorrect operation of the light output control.

The object of the invention is to avoid these drawbacks and to provide a flash unit with greater operational reliability, using simpler and therefore cheaper components.

In accordance with the invention, an electronic flash device with automatic light-output control, comprises a flash tube which is supplied by a flash capacitor and ignited by operation of a trigger contact, and a control circuit including a light-sensitive component for terminating the flash, wherein an electronic ignition switch operates under the control of the trigger contact to discharge an ignition capacitor through an ignition transformer to trigger the flash tube, a main

electronic switch completes the flash-tube circuit when the ignition switch operates, and an electronic quenching switch is operated under the control of the light-sensitive component to connect a quenching capacitor to the main electronic switch to cause the latter to interrupt the flash-tube circuit and so terminate the flash. Preferably the control voltage of the main electronic switch is derived from a resistor in circuit with the ignition switch.

The device is then such as to switch reliably and to be adaptable for close range working. At close range there is a risk that because of the application of a high light intensity to the photosensitive component, the quenching switch will be returned after a short time to its conductive state and the main electronic switch itself returned to its conductive state, without the help of the ignition switch, as a consequence of the amplitude of the damped oscillation developing in the primary circuit of the ignition transformer, so that effective light-output control is no longer exercised.

In an advantageous embodiment of the invention, the ignition switch is a thyristor in shunt to the series combination of a glow discharge tube and a resistor, the resistor being bridged by a capacitor the voltage of which is applied through the trigger contact to the control electrode of said thyristor.

The capacitor, on triggering, supplies to the gate of the thyristor a pulse which is of such magnitude that the thyristor immediately becomes fully conductive, and this results in a pulsing of the main electronic switch, which pulse likewise fully opens this switch. It is therefore possible both for the main switch and for the ignition switch to comprise thyristors of a low power dissipation and therefore of low cost.

It is particularly advantageous to connect a voltage divider across the flash capacitor, with a tapping for the charging of the quenching capacitor and a tapping providing a lower voltage for controlling the ignition switch. This ensures that the full supply voltage for the ignition thyristor, and for the quenching switch which is desirably a triggered gas discharge tube which does duty as an indicator showing that the unit is ready for service, is only made available when the flash capacitor has fully charged up, thus excluding the possibility that, for example due to the effect of the light from another flash unit, the flash capacitor is discharged with the result that if the unit primarily under discussion is operated immediately thereafter, output control can no longer be effective.

An electronic flash unit embodying the invention, to provide a reliable switching mechanism for light control, will now be described by way of example and with refer-

ence to the accompanying drawing, the single figure of which is a circuit diagram of the flash unit.

In the figure, in parallel with a flash capacitor 1 there is a series circuit formed by a flash tube 2, a thyristor 3 doing duty as the first control element and a resistor 4, as well as a series circuit formed by resistors 5 and 6, a thyristor 7 doing duty as the second control element, and a resistor 8. The ignition electrode of the thyristor 3 is connected between the cathode of the thyristor 7 and the resistor 8. From the junction of the resistor 6 and the anode of the thyristor 7, an ignition capacitor 9 is connected in series with the primary winding of an ignition transformer 10 the secondary of which is connected to the ignition electrode 11 of the flash tube 2. Parallel with the thyristor 3, there is a series circuit comprising a storage capacitor 12 and a switching tube 13, as well as a resistor 14. The anode of the switching tube 13 is connected to the junction of the resistors 5 and 6.

Shunted across the resistor 4 there are a capacitor 15, a resistor 16, and the collector-emitter region of a phototransistor 17, which serves as the photosensitive element, in series with a load resistor 18. An integrating circuit, constituted by a resistor 19 in series with a capacitor 20 shunted by a resistor 21, couples the emitter of the phototransistor 17 to the control electrode of a thyristor 22 the anode of which is connected through a resistor 23 to the supply voltage, the latter being picked off between the resistor 6 and the anode of the thyristor 7 and applied across an ignition capacitor 24 to the primary winding of a second ignition transformer 25. The secondary winding of the transformer 25 is connected to the ignition electrode 26 of the switching tube 13. The ignition electrode of the thyristor 7 is connected across a resistor 27 to the reference potential of the circuit arrangement and directly to the trigger contact 28 of the flash unit.

Shunted across the flash capacitor 1, via the resistors 5 and 6, there is a glow-discharge tube 29 whose negative electrode is taken to a parallel arrangement comprising a resistor 30 and a capacitor 31, and across the trigger contact 28 to the ignition electrode of the thyristor 7.

On application of the supply voltage for the unit, to the terminals 32 and 33 of the arrangement, the storage capacitor 12 is charged up. Only when the latter has reached a set voltage is there a sufficient voltage between the resistor 6 and the anode of the thyristor 7 for the glow-discharge tube 29 to ignite so that the capacitor 31 starts to charge. Only when the capacitor 31 has charged up, is the arrangement ready for service, and it should be arranged that

the charging time of the capacitor should be shorter than the reaction time of the human operator.

5 If the trigger contact 28 is operated, then the discharge pulse from the capacitor 31 is supplied to the gate of the thyristor 7; this pulse should be of sufficient amplitude to drive the thyristor immediately into its fully conductive state. A pulse is consequently
10 applied immediately to the gate of the thyristor 3 which in turn becomes fully conductive. The switching of the thyristor 7 produces a discharge pulse on the part of the ignition capacitor 9 across the primary of the ignition transformer 10 so that in the
15 secondary of the latter a voltage pulse is induced and applied to the ignition electrode 11 of the flash tube 2 to ignite that flash tube.

20 With the ignition circuit of the flash tube 2 closed, across the resistor 4 a voltage drop appears which forms the supply voltage for the photo-transistor 17. The capacitor 15 is charged up and a diode 34 between the
25 resistor 4 and the capacitor 15 prevents any unwanted discharge on the part of the capacitor.

If part of the light reflected by the illuminated object strikes the phototransistor
30 17, then the latter produces an integrated voltage as a consequence of the integrating properties of the capacitor 20, and the thyristor 22 changes to its conductive state. Then the ignition capacitor 24 discharges
35 across the primary of the second ignition transformer 25 in the secondary of which a voltage pulse is induced and applied to the ignition electrode 26 of the switching tube 13, causing the latter to strike.

40 The circuit is so designed that the current through the switching tube 13 is greater than that through the flash tube 2. The storage capacitor 12 discharges across the resistors 5, 14 and 4. The thyristors 3,
45 provided that the discharge current is supplied for the time required for recombination, reverts to the blocked condition and thus interrupts the ignition circuit of the flash tube 2. The required size of the storage
50 capacitor 12 thus depends upon the recombination time of the thyristor 3.

WHAT WE CLAIM IS:—

55 1. An electronic flash device with automatic light-output control, comprising a flash tube which is supplied by a flash capacitor and ignited by operation of a trigger

contact, and a control circuit including a light-sensitive component for terminating the flash, wherein an electronic ignition switch
60 operates under the control of the trigger contact to discharge an ignition capacitor through an ignition transformer to trigger the flash tube, a main electronic switch completes the flash-tube circuit when the ignition
65 switch operates, and an electronic quenching switch is operated under the control of the light-sensitive component to connect a quenching capacitor to the main electronic switch to cause the latter to interrupt
70 the flash-tube circuit and so terminate the flash.

2. An electronic flash device according to claim 1, wherein the control voltage for the main electronic switch is derived from
75 a resistor in circuit with the ignition switch.

3. An electronic flash device according to claim 1 or 2, wherein the ignition switch is a thyristor in shunt to the series combination of a glow discharge tube and a resistor, the resistor being bridged by a capacitor
80 the voltage of which is applied through the trigger contact to the control electrode of said thyristor.

4. An electronic flash device according to claim 1, 2 or 3, wherein a voltage divider is connected across the flash capacitor, with
85 a tapping for the charging of the quenching capacitor and a tapping providing a lower voltage for controlling the ignition switch.

5. An electronic flash device according to any one of the preceding claims, wherein the quenching switch is a triggered discharge tube.
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6. An electronic flash device according to any one of the preceding claims, wherein the main electronic switch is a thyristor with a cathode resistor which provides the
100 supply voltage for the light-sensitive component.

7. An electronic flash device with automatic light-output control substantially as herein described with reference to the accompanying drawing.
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With the ignition circuit of the flash tube 2 closed, across the resistor 4 a voltage drop appears which forms the supply voltage for the photo-transistor 17. The capacitor 15 is charged up and a diode 34 between the resistor 4 and the capacitor 15 prevents any unwanted discharge on the part of the capacitor.

If part of the light reflected by the illuminated object strikes the phototransistor 17, then the latter produces an integrated voltage as a consequence of the integrating properties of the capacitor 20, and the thyristor 22 changes to its conductive state. Then the ignition capacitor 24 discharges across the primary of the second ignition transformer 25 in the secondary of which a voltage pulse is induced and applied to the ignition electrode 26 of the switching tube 13, causing the latter to strike.

The circuit is so designed that the current through the switching tube 13 is greater than that through the flash tube 2. The storage capacitor 12 discharges across the resistors 5, 14 and 4. The thyristors 3, provided that the discharge current is supplied for the time required for recombination, reverts to the blocked condition and thus interrupts the ignition circuit of the flash tube 2. The required size of the storage capacitor 12 thus depends upon the recombination time of the thyristor 3.

WHAT WE CLAIM IS:—

1. An electronic flash device with automatic light-output control, comprising a flash tube which is supplied by a flash capacitor and ignited by operation of a trigger

contact, and a control circuit including a light-sensitive component for terminating the flash, wherein an electronic ignition switch operates under the control of the trigger contact to discharge an ignition capacitor through an ignition transformer to trigger the flash tube, a main electronic switch completes the flash-tube circuit when the ignition switch operates, and an electronic quenching switch is operated under the control of the light-sensitive component to connect a quenching capacitor to the main electronic switch to cause the latter to interrupt the flash-tube circuit and so terminate the flash.

2. An electronic flash device according to claim 1, wherein the control voltage for the main electronic switch is derived from a resistor in circuit with the ignition switch.

3. An electronic flash device according to claim 1 or 2, wherein the ignition switch is a thyristor in shunt to the series combination of a glow discharge tube and a resistor, the resistor being bridged by a capacitor the voltage of which is applied through the trigger contact to the control electrode of said thyristor.

4. An electronic flash device according to claim 1, 2 or 3, wherein a voltage divider is connected across the flash capacitor, with a tapping for the charging of the quenching capacitor and a tapping providing a lower voltage for controlling the ignition switch.

5. An electronic flash device according to any one of the preceding claims, wherein the quenching switch is a triggered discharge tube.

6. An electronic flash device according to any one of the preceding claims, wherein the main electronic switch is a thyristor with a cathode resistor which provides the supply voltage for the light-sensitive component.

7. An electronic flash device with automatic light-output control substantially as herein described with reference to the accompanying drawing.

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